

HARRIS

Relation of Specific Gravity
of the Blood to the
Corpuscular Elements

SCIENCE
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1903

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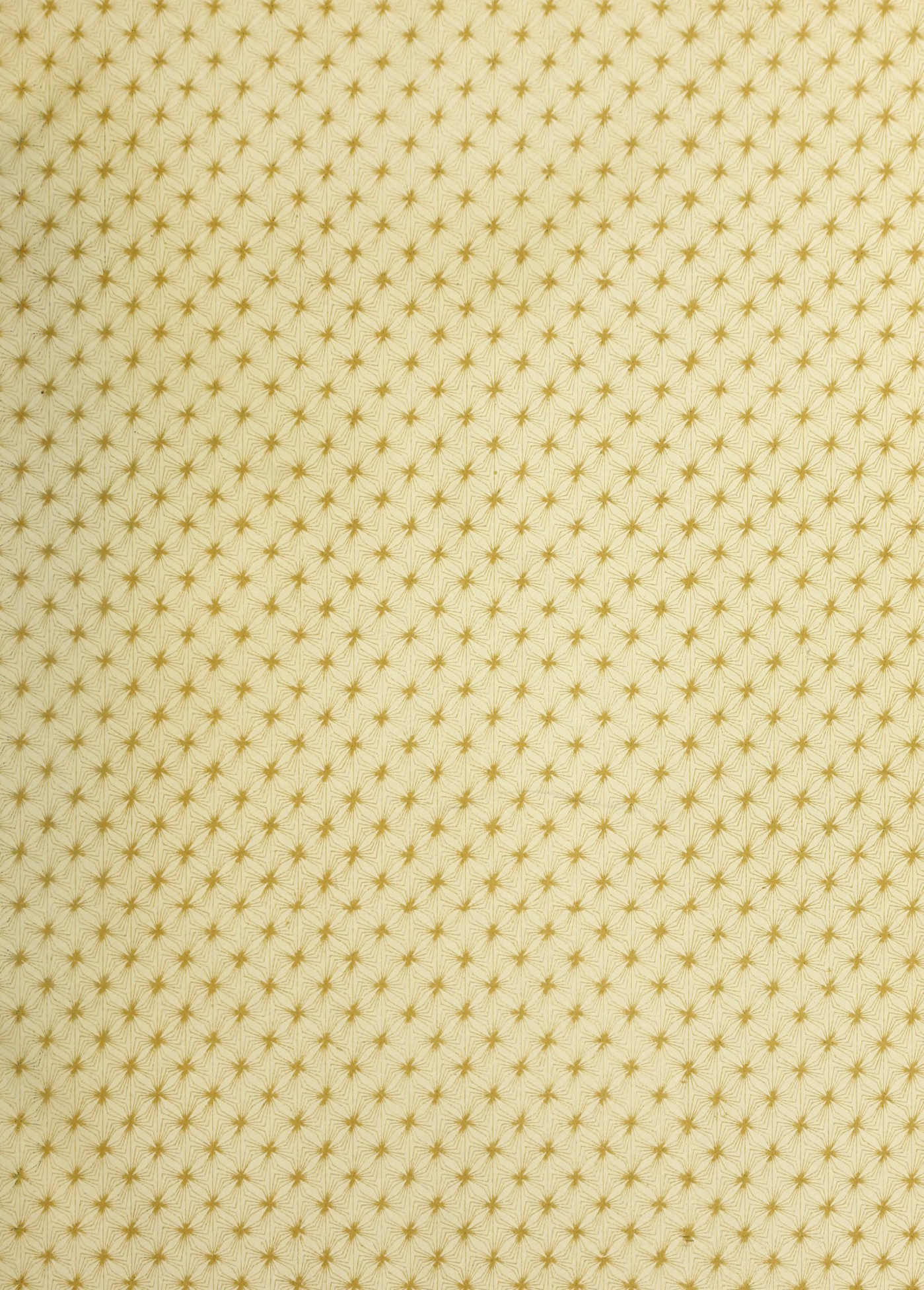
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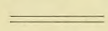


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21 of 2

The Relation of the Specific Gravity of the Blood to the Corpuscular Elements

. BY .

CHESTER ELLIS HARRIS



THESIS

FOR THE

DEGREE OF BACHELOR OF ARTS

IN THE

COLLEGE OF SCIENCE

UNIVERSITY OF ILLINOIS

1902

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May 31.

1902
H24

B.A.F.

UNIVERSITY OF ILLINOIS

May 30

1902

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Chester Ellis Harris

ENTITLED *The Relation of the Specific Gravity of
the Blood to the Corpuscular Elements*

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF *Bachelor of Arts*

Geo. T. Kemp

HEAD OF DEPARTMENT OF *Physiology*

UNIVERSITY OF ILLINOIS

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[Faint, illegible text]



In some researches, recently carried on in this laboratory, on the regeneration of red corpuscles and blood-plates, made by bleeding dogs and watching the formation of these elements of the blood; variations were found in the counts made from day to day, for which there was no apparent explanation. It was thought that these variations could be shown to be due to a varying percentage of water in the blood, and accordingly the specific gravity was also taken in subsequent observations. It soon became apparent that the relation of the specific gravity to the number of red corpuscles, was not a simple one, and it was for the purpose of determining what relation, if any, existed between them that a more careful study of the specific gravity of the blood, was undertaken.

In our observations we made use of a method, which, so far as we know, has not been used before. This method consisted in making a count of the red corpuscles, a determination of the haemoglobin, and an estimation of the specific gravity, (and, in some cases a count of the white corpuscles also), from the same drop of blood. We were able to do this, by having three or four practised observers all working together. One person attended

consequently the frequency of the count of the particles
count, a second set of measurements performed, than
for a single count of the same particles with the
same counter as the first count. The average value
of a fourth count is a count of the whole in
particles, when such count was included in the
second count.

In various experiments, the different counters
used were always checked by means of readings
by different members of the party, and the results
of an actual observation, were reduced to a com-
mon scale.

The set of particles were also counted, and also
by the house gas counter, and some
times by the counter. A careful comparison of
these two instruments was made. The results of
these observations as well as the special methods
employed will be given in a separate chapter.
It may be said, however, that the counter
yielded results equally consistent with those ob-
tained by the house counter, and was therefore
employed for convenience, in order for the greater
number of our experiments. It may be said
given in our tables it will be understood that
these were obtained with the counter, unless
specially noted to the contrary.

The specific gravity was taken by Baumé's hydrometer, using a very small amount of solution to determine the specific gravity of the liquid under examination.

The haemoglobin was determined by Fleischl's haemometer.

The most satisfactory procedure is to dilute with the same quantity of water with the same water as used in the test, and use a standard solution of haemoglobin at present. The dilution of the solution must be reported in the thesis.

The determination of the amount of red corpuscles.

In order to make our investigations as thorough as possible, we decided to test the accuracy of the instrument employed. As the standard has not been stated, we determined the accuracy of the corpuscles by the haemoglobin test, and also by the haemometer.

Determination by the haemometer.

Counts with the haemometer were made in the ordinary manner using as a standard fluid, a solution of the following formula:

SB - Salt in 25 - 1000 - 1000 - 1000
95% Alcohol 6 c.c.

we were using this solution in another part of our
work where it was necessary to have a fluid which
would preserve the cells of the blood but the
same time would permit them to be further examined
by other means. Reference will be made to this later.
We tried this solution and found that it preserved
the corpuscles excellently both in form and in
color.

In order to determine the accuracy of the
counting chamber we took a number of
countings were taken to secure accuracy. In all cases
we counted several hundred cells in a single field
and counted the whole of the counting chamber
in all. We counted forty-four small
squares to determine what our error in the in-
strument we made. We counted from the same
drop of blood, in three different counting cham-
bers. The results were as follows:

Brown counting chamber A.	4'900'000.
Brown counting chamber B.	4'900'000.
Brown counting chamber C.	4'600'000.

In other words the error in the counting chamber
is different in each case and the error in the
counting chamber is the error in the counting chamber.

No.	Count by K.	Count by S.	Difference
1	5,700,000	8,000,000.	+ 300,000.
2	6,475,000.	6,700,000.	+ 225,000.
3	8,200,000.	7,850,000.	- 350,000.
4	8,326,000.	8,300,000.	- 26,000.
5	5,450,000.	5,700,000	+ 250,000.
6	7,750,000.	7,900,000.	+ 150,000.
7	6,150,000.	5,700,000.	- 450,000.
8	6,100,000.	6,250,000.	+ 150,000.

Each of these counts was made from a field of *salmon mulligenae*.

However these were counts just only, the same was examined, K. and S. made a number of observations in which the error was determined as being different from the usual counts, each person counting from a pipette prepared by himself but from the same stock. We give here his experiments and the conclusions he draws from them.

Case I.

Each working independently

Sadler 4'43'500.

Sadler 3'00'000.

Difference 1'043'500.

3. Ribetti and slide were exchanged.

Sadler.....4'162'000.

Daland.....3'525'000.

Difference 337'000.

Discrepancy

4. Daland's Mixture

Sadler.....4'507'000

Daland, same field.....4'687'500.

Difference.....000'000.

5. Daland's Mixture

Daland.....4'000'000.

Sadler.....4'150'000.

Difference 150'000.

Discrepancy

a

Sadler's Mixture

Sadler two preparations 4'913'500.

4'725'000.

Difference 187'500.

Daland counted one preparation from the same mixture. 4'462'500.

Sadler's second count 4'818'750.

Difference 356'250.

b

Daland's Mixture

Daland two preparations 3'700'000.

3'175'000.

Difference 525'000.

Sadler counted one preparation
 Grand total count 4'00'000
 Daland's mean count. 3'431'500.
 Difference 568'500.

mean of all Sadler's counts. 4'128'725.
 mean of all Daland's counts 3'247'250.
 Difference 1'381'250.

Case I.

a. Sadler 6'225'000.
 Daland 6'225'000.
 Difference 0'000'000.
 Difference 0'000'000.

b. Sadler another preparation 6'162'000.
 Daland another preparation 5'612'000.
 Difference 550'000.

Daland counted 64 squares. 5'925'000.
 Sadler counted 64 squares. 5'750'000.
 Difference. 175'000.

Case II

a. Sadler 6'212'000
 Daland 5'850'000.
 Difference 362'000.

Sadler 50 preparations
 Daland two preparations 6'000'000.
 Difference 6'2'000.

Sadler 64 squares 5'925'000.
 Daland 64 squares 5'975'000.
 Difference 50'000.

Case 5.

Daland one preparation 7'000'000
 Sadler one preparation 3'687'500.
 Difference 3'312'500.

Case 6.

Sadler 4'125'000.
 Daland 4'312'500.
 Difference 862'500.

Case 7.

Sadler 4'000'000
 Daland 4'887'500.
 Difference 887'500.

From these experiments it can be seen that if only
 four squares are used in the great majority the
 two methods will give a difference of about 400. This would
 mean that if only four squares were used, the
 result would be the same. However, the number
 of squares used in the great majority is

small drop, while the latter is a small drop, and they are both careful to avoid any possibility of the glass to get nervous rings.

After numerous papers the results of the experiment in this work, the first one² is that a necessary is to be obtained with the same of similar only with two or three pairs; preparations are taken and are by four or more similar instances.

The extreme variation in the results of the experiment in this work has caused the interest in the work was, it is said. This statement is made even though only two experiments in this work, and a number of experiments been made, as was done by us, larger variations would probably have been found in some cases. Owing to consider that, a difference of one or two parts in the count of little small pieces, makes a difference of 1/10th, thus small differences in the count, it is, not surprising that variations in large quantities of 1/10th, there are not occasionally to be met with.

making was done in a watch glass. The animal secret tubes were filled by attaching a piece of rubber tubing and applying suction with the mouth, after which they were placed in the jar and covered by water for 10 minutes. At the end of this time the blood column had become stationary, and was sharp in mass of the thickness of the glass.

Saline fluids that of the same nature and composition solution are mixed in the ampulla of the pipette and the amount of blood in the pipette is the amount comes out eight to ten percent low, due to the amount of blood which sticks to the walls of the pipette, and does not mix with the bichromate solution.

In repeating these experiments of sedimentation, we scratched a number of pipettes and found that no any tube possessed a sufficient amount of sediment to be detected, since we always centrifuged two tubes of the same specimen of blood at the same time. See table number X.

Quinn compared the haematocrit with the same of another series, and was able to find that the number of red corpuscles in the blood and the results are given in table number 11. (See also page 100.)

No	Microometer	Stomatometer	Difference
1	3'837'625	3'600'000	207'625
2	4'279'000	4'400'000	121'000
3	4'128'125	4'100'000	28'125
4	5'858'333	4'900'000	958'333
5	2'747'500	2'800'000	52'500
6	3'843'750	3'600'000	243'750
7	1'770'750	1'800'000	29'250
8	4'606'250	4'600'000	6'250

This table shows a comparison of the microometer and the stomatometer, taken into by water. In cases four and five it is to be seen the greatest difference. In these two experiments the blood for the stomatometer was more than shown for the microometer pipette, and it also had an increased thickness in cent. It was supposed that part of the blood stuck to the pipette and was not mixed. On this account the reading came eight to ten percent less as already has explained. If this eight to ten percent be added to the counts obtained by the stomatometer the difference between the two counts as determined by the two different methods would be only two hundred thousand, which is within the practical limit of error of either instrument. That this is justifiable, is shown in case six. In this experiment,

		Hemacylon	with Haemocrit	Hemacylon	Hemacylon to H. p.
1	35.0	3'237'500	2'500'000	1'000'000	60'038
2	32.8	3'150'000	3'000'000	1'50'000	59'660.
3	50.	5'450'000	4'000'000	1'950'000	74'377.
4		5'775'000	4'400'000.	1'375'000	---
5	35	5'475'000	5'400'000.	575'000	70'294
6		5'463'000	4'800'000	663'000	---
7		1'200'000	1'200'000	250'000	
8	30	600'260	1'200'000.	599'740	60'026
9	30	562'500	800'000.	237'500	56'250
10		1'122'000.	1'000'000	122'000	
11	30	5'437'500.	4'400'000	1'137'500	67'968
12		5'375'000.	3'200'000	2'175'000	---
13		1'200'000.	3'000'000	1'800'000	
14	30	4'412'000.	3'600'000	812'000	80'218
15	25	4'180'000.	3'000'000	1'180'000	76'000
16	-	3'181'808.	2'500'000	981'808	---
17	-	3'593'750.	2'400'000.	1'193'750	---
18	-	2'230'000	2'000'000	230'000	---
19		5'200'000	5'000'000	200'000	
20		4'157'500	1'800'000	2'357'500	
21	30	2'112'500.	1'100'000	1'012'500	77'500
22	25	3'637'500.	2'800'000	1'837'500	80'833
23	20	2'062'800.	1'700'000	1'700'000	68'760

Table 12

Source: *Manuscript of Francis H. Taylor, 1866*

24		2'100'000	1'650'000	1'210'000	---
25	34	2'187'500	1'600'000	1'175'000	72'800
26		2'100'000	4'200'000	1'762'500	---
27		2'100'000	3'300'000	1'110'000	---
28	35	5'960'000	3'600'000	2'360'000	132'444
29		2'225'000	3'500'000	1'637'000	---
30	36	3'025'000	2'000'000	1'025'000	75'625
31	37	2'900'000	2'400'000	500'000	72'500
32	38	3'160'000	2'500'000	660'000	79'000
33		3'575'000	2'200'000	1'375'000	---
34		3'112'500	3'000'000	170'969	---
35	39	4'830'000	3'500'000	2'500'000	1'720'000
36		4'830'000	4'200'000	630'000	---
37	40	5'864'500	4'800'000	1'224'500	1'224'500
38		5'037'500	5'000'000	375'000	---
39	41	5'387'500	3'000'000	1'750'000	1'750'000
40	42	3'974'500	3'000'000	974'500	61'146
41	43	3'200'000	2'700'000	500'000	41'428
42		4'637'500	3'100'000	837'500	---
43		3'137'500	3'100'000	137'500	---
44	44	2'912'000	2'900'000	12'000	2'900'000

his number 11 - list in Documents, paper 1 shows that
the results of the unmanipulated analysis of the
crystallographic measurements, first, to the very
small given by the X-ray analysis - second, in
most cases only one preparation of very good
quality, was made; second, to the fact that the
measurements were taken in a very
poorly fitted, and was consequently subject to
temperature error.

A study of the results, and of the
data to the same conclusion that, in fact,
if that rather - that the unmanipulated
data is a complete result, as shown by
the study and a piece of the practice, less than
any of the cases and what will very much
less time.

Time	Temp. (°C)	Temp. (°F)	Bar. (mm)	Bar. (in)	Bar. (ft)
10	20	68	760	30	30
15	21	70	760	30	30
20	22	72	760	30	30
25	23	73	760	30	30
30	24	75	760	30	30
35	25	77	760	30	30
40	26	79	760	30	30
45	27	81	760	30	30
50	28	82	760	30	30
55	29	84	760	30	30
60	30	86	760	30	30
65	31	88	760	30	30
70	32	90	760	30	30
75	33	91	760	30	30
80	34	93	760	30	30
85	35	95	760	30	30
90	36	97	760	30	30
95	37	99	760	30	30
100	38	100	760	30	30

with each thermometer, the

several chambers were situated on the different parts
 of the mountain, and the results of the observations
 were compared with those of the other instruments.
 The results of these observations are given in tables
 numbered 1 to 12.

TABLE I

Time	Barometer	Thermometer	Wind	Direction	Force	Clouds	Remarks
10	30.0	50	SE	1	0	0	
11	30.0	50	SE	1	0	0	
12	30.0	50	SE	1	0	0	
13	30.0	50	SE	1	0	0	
14	30.0	50	SE	1	0	0	
15	30.0	50	SE	1	0	0	
16	30.0	50	SE	1	0	0	
17	30.0	50	SE	1	0	0	
18	30.0	50	SE	1	0	0	
19	30.0	50	SE	1	0	0	
20	30.0	50	SE	1	0	0	

TABLE II

Time	Barometer	Thermometer	Wind	Direction	Force	Clouds	Remarks
10	30.0	50	SE	1	0	0	
11	30.0	50	SE	1	0	0	
12	30.0	50	SE	1	0	0	
13	30.0	50	SE	1	0	0	
14	30.0	50	SE	1	0	0	
15	30.0	50	SE	1	0	0	
16	30.0	50	SE	1	0	0	
17	30.0	50	SE	1	0	0	
18	30.0	50	SE	1	0	0	
19	30.0	50	SE	1	0	0	
20	30.0	50	SE	1	0	0	

in comparing the figures in these tables of
the covers at one party in the same time. The
depth of color appears to match at quite a different
point. The color difference is not the same
good preparation on the same instrument, the
various differences would be much less.
The same difference is seen even when
by the same cover, for the same instrument
at different instruments, and the same
and the same made to be the same
amount with the preparation of the same
being known that previous work. The amount
in the other readings was not the same.

Now this is not to be taken that the same
amount is seen in the instrument by one
or two of, is not more than in these individual
individual differences. The percentage of error
from the same drop of blood on the same
first part of the instrument is not the same
may be more or less. When the same
the specimens are different, for the same
drop of blood on the same instrument, the
error is different. The error is
to be as great as follows.

Now the same instrument is

gravity of the blood, and he has also studied the specific gravity of the blood in various diseases. The results of his observations on anemic blood are given in table III, and are of value for comparison with our own observations on normal blood given in table

His researches are the fullest we have been able to find in the literature of the subject. His summary is given in the following table:

(1) In the normal condition the specific gravity of normal blood is very variable.

(2) In cases of anemia the specific gravity is lower than in the normal condition, and is usually found to be lower than the average of this.

(3) In cases of hyperemia, as in the case of the marked anemia treated by Kunkin, the specific gravity is higher than in the normal condition, and is usually found to be higher than the average of this.

(4) In cases of polycythemia, as in the case of the anemia treated by Kunkin, the specific gravity is higher than in the normal condition, and is usually found to be higher than the average of this.

Line	Quantity	Unit	Amount	Notes
1	100	30	3'364'000	
2	100	30	2'972'000	
3	100	30	2'728'000	
4	100	30	4'400'000	
5	100	30	—	
6	100	30	2'448'000	
7	100	30	3'352'000	
8	100	30	—	
9	100	30	3'360'000	
10	100	30	—	
11	100	30	—	
12	100	30	3'380'000	
13	100	30	—	
14	100	30	—	
15	100	30	3'604'000	
16	100	30	3'440'000	
17	100	30	—	
18	100	30	—	
19	100	30	3'376'000	
20	100	30	—	
21	100	30	—	
22	100	30	—	
23	100	30	—	
24	100	30	—	
25	100	30	—	

III (continued)

No.	Length	Width	Number of red. capsules	Ratio of reds to total
21	1.00	1.00		
22	1.00	1.00	3'096'000	
23	1.00	1.00		
24	1.00	1.00	4'068'000	
25	1.00	1.00		
26	1.00	1.00		
27	1.00	1.00		
28	1.00	1.00		
29	1.00	1.00		
30	1.00	1.00	3'536'000	
31	1.00	1.00		
32	1.00	1.00		
33	1.00	1.00		
34	1.00	1.00		
35	1.00	1.00		
36	1.00	1.00		
37	1.00	1.00		
38	1.00	1.00		
39	1.00	1.00		
40	1.00	1.00	4'64'000	
41	1.02	1.00		
42	1.03	1.00		

City	Wards	Number of vol Bapt. churches	Ratio of value of Sp. Encl. Co. p. 100
1870	12	10	—
1875	12	10	7'008'000
1880	12	10	4'664'000
1885	12	10	—
			3'352'000

I sincerely trust that the above figures are correct, and
 suffering from a mistake in copying, and not from any
 of the same number of churches, and not from any
 as a party of 1000, when the value of the land
 is being calculated, which is the case of the
 land, have a specific gravity of 1058, with the
 potential of about 1000, and not to be
 to use the specific gravity of 1058, with the
 value of about 1000, and not to be
 the case of a party of 1000, when the value of the
 land is being calculated, which is the case of the
 land, have a specific gravity of 1058, with the
 potential of about 1000, and not to be

In the absence of these figures, it is not
 possible to give the value of the land, and not to be
 made, and not to be made, and not to be made,
 and not to be made, and not to be made, and not to be made,
 and not to be made, and not to be made, and not to be made,

which large percentage is produced by partial
recirculation and shows a greater number of red
puscles than is in the general circulation.

Wright found that in the thoracic lymphatic system
there is a very marked stasis, the number of red
cells being (Wright's table) increased.

Wright found that by holding the feet over fire
for 15 minutes the blood count of the
arterial blood from the foot was normal
and decreased again after the usual number of
minutes of movement.

In the general paper by W. M. W. Wright, J. H. W. Wright
with illustrations to show the circulation in the
foot of a person of the blood count, the amount of
hemoglobin, the amount of the red cells, the
the specific gravity and the percentage of hemoglobin
in the blood from the foot and the amount of hemoglobin
and the number of red corpuscles and W. M. W. Wright
concluded that the specific gravity of the blood in the
arterial blood from the foot was normal and the amount of
hemoglobin in the blood from the foot was normal and the
number of red corpuscles in the blood from the foot was
normal. It was concluded that the amount of hemoglobin
in the blood from the foot was normal and the amount of
hemoglobin in the blood from the foot was normal and the
number of red corpuscles in the blood from the foot was
normal. The specific gravity of the blood in the
arterial blood from the foot was normal and the amount of
hemoglobin in the blood from the foot was normal and the
number of red corpuscles in the blood from the foot was
normal.

...in the mixture before the estimation...
...the specific gravity kn... to read...
...mentions this in his article on the haemo-
...in which case the fluids of the blood
...diffused and the residue sank. This element
...at a certain point...
...the fluids of the blood
...diffused and the residue sank. This element
...at a certain point...
...the fluids of the blood
...diffused and the residue sank. This element
...at a certain point...

The effect of repeated... the
...and are therefore...
...Their results, however,
...obtained under...
...and are therefore...
...Their results, however,
...obtained under...
...and are therefore...
...Their results, however,
...obtained under...
...and are therefore...

Financial Statement

Income Statement for the Year ended 31st December 1955

		Amount	
1	Revenue	5,300,000	Profit
2	Cost of Sales	2,500,000	Profit
3	Gross Profit	2,800,000	
4	Operating Expenses	5,650,000	Loss
5	Operating Loss	2,850,000	
6	Finance Costs	1,700,000	Loss
7	Operating Loss	4,550,000	
8	Other Income	1,000,000	Profit
9	Operating Loss	3,550,000	
10	Income Tax	5,500,000	Loss
11	Operating Loss	9,050,000	
12	Other Income	3,700,000	Profit
13	Operating Loss	5,350,000	
14	Income Tax	5,300,000	Loss
15	Operating Loss	10,650,000	
16	Other Income	5,250,000	Profit
17	Operating Loss	5,400,000	

		Amount	
1	Revenue	5,300,000	Profit
2	Cost of Sales	2,500,000	Profit
3	Gross Profit	2,800,000	
4	Operating Expenses	5,650,000	Loss
5	Operating Loss	2,850,000	
6	Finance Costs	1,700,000	Loss
7	Operating Loss	4,550,000	
8	Other Income	1,000,000	Profit
9	Operating Loss	3,550,000	
10	Income Tax	5,500,000	Loss
11	Operating Loss	9,050,000	
12	Other Income	3,700,000	Profit
13	Operating Loss	5,350,000	
14	Income Tax	5,300,000	Loss
15	Operating Loss	10,650,000	
16	Other Income	5,250,000	Profit
17	Operating Loss	5,400,000	

Where the pressure is slight, the specific gravity
tendency to water is less than in the unaltered
ice without pressure, but the variation is
insignificant and is generally due to the
slight change of temperature.

In comparing the specific gravity with the
number of feet of ice, and the percentage
of ice in the total ice found, the data to be
used of these first are intended to show
when pressure was used, the increase was
by no means in the same ratio, and in
fact was not more than a small amount
factor, while a small increase was seen in
the other two. These experiments were not
made with the greatest care, and all
possible records were recorded. The small
length of time, however, that each of the
first series, taken out from the water
depth of about a mile, in which it would
be felt that the experimentally found
percentages were. The number of feet of
ice in the total ice is more than that from
the first series. In these problems
it is not possible to determine, but the
of ice, the number of experiments, and
the percentage of ice in the total

... these factors can be taken as an accurate measure for either of the other two.

In this series of experiments it was found that the effect of pressure on the growth of human tubercles was from the fact, as related to pressure, to find that strong pressure diminished the amount of human tubercles in the blood, but not at all in the tissue of the lung, as the tubercles were withdrawn from the vessels.

It must be noted that these experiments showing the effect of pressure on the number of pus cells as well as on the amount of human globin. These experiments were made on a tubercle patient for specimens of blood being drawn from the same puncture at different intervals of time and with different degrees of pressure.

Human tubercles for count of pus cells
Number per cu. mm. 4082000
2. Human for human globin etc. a patient human
globin for count of tubercles
3. Human for human globin etc. strong pressure
as a source to pressure) Pus cells 3860000.

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